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STATE OF ALASKA

William A. Egan, Governor


# ANNUAL REPORT OF PROGRESS, 1963 - 1964

# FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-5

# SPORT FISH INVESTIGATIONS OF ALASKA

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# INTRODUCTION

This report of progress consists of Job Segment Reports from the State of Alaska Federal Aid in Fish Restoration Project F-5-R-5, "Sport Fish Investigations of Alaska."

The project is composed of 25 separate studies designed to evaluate the various aspects of the State's recreational fishery resources. Of these, eight jobs are designed to continue the cataloging and inventory of the numerous State waters in an attempt to prepare an index of the recreational waters. Four jobs are designed for specific sport fishery creel census while the remainder of the jobs are more specific in nature. These include independent studies on king salmon, silver salmon, grayling, Dolly Varden, a statewide access evaluation program, egg take program and a residual toxaphene study. The information gathered from the combined studies will provide the necessary background data for a better understanding of local management problems and assist in the development of future investigational studies.

The subject matter contained within these reports is often fragmentary in nature. The findings may not be conclusive and the interpretations contained therein are subject to re-evaluation as the work progresses.

Volume 5 Report No. 14-B

JOB COMPLETION REPORT

RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska.

Project No. F-5-R-5 Title: Investigations of the Tanana River Grayling Fisheries: Migration Study.

Job No. 14-B

Period Covered. July 1, 1963 to December 31, 1963.


Abstract:

During the 1963 field season a total of 1,231 grayling was tagged in the Goodpaster River, the Delta Clearwater River, the Richardson Clearwater River and Shaw Creek. For ease in handling and to minimize harm to the fish, all fish were quieted by placing them in MS-222. Fork length, dates tagged and areas tagged were recorded on all fish that were tagged with a yellow plastic subcutaneous tag placed on the ventral surface medially and posteriorly to the pectoral fins.

A total of 152 tagged grayling was recovered in the summer season. Fork lengths, date recovered and area recovered were recorded. Analysis indicates a movement trend from the Goodpaster River into the Delta Clearwater River and the Richardson Clearwater River. However, the majority of the tagged grayling were recovered in the stream in which the fish were tagged.

Scale samples were collected from all the grayling that were handled during the year. This includes tag recoveries. Scale measurements have shown that a nearly parallel relationship exists between scales of grayling from different rivers.

Sixty-seven stomach samples were collected and analyzed for comparative study. Analysis and identification have shown that a preference for Ephemeroptera usually exists but that other invertebrates, such as Apidae, may be predominant at times.

Recommendations:

Continue tag and recovery efforts on this three-stream complex. In addition, scale samples should be taken from the fish captures. Studies further illustrating the food habits and stream habitat types should be made.

Objectives:

Maximum effort was place on tagging and recovering grayling to determine movements and migrations. Previously tagged grayling were recovered to determine growth, and scales were collected to determine age. Stomach samples, stream bottom samples and river characteristics were recorded in an attempt to relate movements to a biological factor.

Techniques Used:

Grayling were captured principally by rod and line. Seining produced a few fish. The fish were anesthetized by submersion in MS-222 and tagged with yellow plastic subcutaneous tags. Migration patterns and growth increments were determined by comparing the area taken and fork length at recovery with the area captured and fork length at tagging. After identification, the stomach contents were analyzed by enumerating the numbers present and estimating the importance of the organism by listing the per cent of the total. Scale measurements were determined by magnifying the scale using a Bausch and Lomb microprojector (15X) and measuring the distance from the center of the focus to the outer edge of the annulus for each year.

Findings:

STOMACH CONTENTS AND FOOD AVAILABILITY

During the summer work season, an attempt was made to determine the quantity and variety of food organisms available to the grayling in each of the sampling streams, excepting Shaw Creek. The objective of this work was to determine the influence, if any, of food availability on migration patterns within these streams.

Since the Delta Clearwater is the key stream in this study, six sampling sites were chosen in this stream. The first site was located immediately above the confluence with the Tanana. The remaining 5 sites were distributed along approximately 20 miles of the stream. The uppermost sampling site was located approximately 2 miles upstream from the last observed grayling.

Originally it was intended that each site would be sampled each day for quantity and variety of organisms, air and water temperatures and changes in stream flow. An attempt was made to capture fish at each sampling site at the time of sampling.

The daily samples were reduced to weekly samples when it became apparent that water temperatures were very stable and no measurable changes were occurring in species composition of aquatic organisms.

The resignation of Tom Nagata in June also restricted the number of man-hours which could be allocated to the investigation of food relationships.

The Richardson Clearwater and the Goodpaster Rivers were sampled at random locations whenever the crew was present.

Due to the complete lack of information on the effects of food relationships on migration patterns, a pilot study was initiated in which five per cent of all captured fish were retained for analysis of stomach contents.

Sampling of the Delta-Clearwater

Water temperatures in the Delta Clearwater were found to be quite stable. At the uppermost station, located at the upper lake and in an area containing numerous springs, water temperature was constant at 41° to 42° F. Farther downstream, progressively greater variation was noted, with the widest fluctuations from 43° to 52° F., occurring at the confluence of the Delta Clearwater and Tanana Rivers. Fluctuations in the downstream water temperatures were correlated with air temperatures.

Stream flow was at a minimum at the commencement of sampling and gradually increased throughout the summer. On May 31, stream flow at the uppermost sampling site was estimated to be 120 cfs and had increased to 135 cfs August 7, when the last sample was taken. A progressively greater fluctuation in stream flow was noted in downstream areas, ranging from 190 cfs on June 2 to 260 cfs on July 25 at the confluence of the Delta Clearwater and Tanana Rivers. No further stream flow data was recorded at the lower site after this date due to a rise in the Tanana River which backed up the Delta Clearwater for several hundred yards.

Bottom sampling revealed large numbers of both larval and adult food organisms distributed throughout the length of the stream. Groups B, C, D, E, F and H were common throughout the stream bottom. One-square-foot bottom samples often yielded from 1 cm to 2 cm of organisms, with the greatest density occurring in moss beds and eddy areas. Quantitative measurements were not emphasized, however, when it became apparent that the number of individuals greatly fluctuated, depending on the exact spot from which the sample was taken within the site area. By sampling a moss bed, large numbers could be collected while a short move would produce meager results from a sandy area. In general, more moss beds are present in the upstream areas and productivity is probably somewhat greater in the upper reaches; however, this could not be statistically proven.

No significant change in species composition of either bottom samples or stomach contents was noted throughout the summer, except that after mid-June a large hatch of mayflies (Ephemeroptera) was a daily occurrence and these insects were utilized extensively throughout the stream.

Thirty stomachs were taken from this stream during the summer. The contents were measured volumetrically and the results are tabulated in TABLE 2. It should be noted that although Group D makes up 29.1 per cent of all ingested food, the majority was taken from only 7 individuals which were captured just after the large mayfly hatches. A larger sample, taken over a longer period of time, may reduce this percentage.

No selectivity toward any particular food organism was noted except toward the large adult mayflies which characteristically appeared in large numbers, but during short periods of time.

All fish taken in this stream were relatively heavy with stomach contents averaging 8.9 milliliters per individual. From this evidence and the large number of food items available throughout the stream, it appears that food availability is not a limiting factor in this stream.

Migration tendencies apparently are not correlated to food availability. In the upper reaches of the stream, no grayling could be found for distances of several miles, although many different types of habitat were available in all locations. Furthermore, when grayling were found

TABLE 1. Invertebrate Identification of Stomach Contents From Grayling (Tanana River Drainage - 1963)

| | | |
|---|---|---|
| Group A | Plecoptera: Nemouridae | Nemoura (Zapada) possibly haysi Rick |
| Group B | Chironomidae | Genus and species Chironomidae |
| Group C | Baetidae | Baetis sp. |
| Group D | Ephemeroptera | (Poor Specimens) |
| Group E | Ephemerellidae | Epheremerella (Drunella) doddsi Needham |
| Group F | Trichoptera: Rhyacophilidae | Rhyacophila sp. |
| Group G | Oligochaeta: Possibly Enchytraeidae | |
| Group H | Plecoptera: Chloroperlidae | Alloperla pallidula (Bks.) |
| Group I & Q | Trichoptera: Limnephilidae | Onocosmoecus unicolor (Bks.) |
| Group J | Plecoptera: Nemouridae | Nemoura (Zapada) sp. probably columbiana |
| Group K | Undetermined | |
| Group L | Undetermined | |
| Group M | Corixidae | Subfamily Corixinae, Tribe Corixini |
| Group N | Trichoptera: Limnephilidae | Apatania crymophila Mch. |
| Group O | Chironomidae: Diamesinae | Genus and species unknown |
| Group P | Undetermined | |

TABLE 1 (Con't) Invertebrate Identification of Stomach Contents From Grayling (Tanana River Drainage - 1963)

| | | |
|---|---|---|
| Group R | | Undetermined |
| Group S | | Apidae |
| | Bombus sp. | |

TABLE 2. Organisms Taken From the Stomachs of Grayling Collected from the Delta Clearwater River (1963)

Delta Clearwater

Total Samples 30

Total Contents 268.4 ml (Average 8.9 ml/sample)

Total Identified 155.1 ml (57.8%)

| Group | % of Diet | Total Contents (in Milliliters) | Frequency of Occurrence | |
|---|---|---|---|---|
| B | 5.4 % | 15.5 | 26/30 | 86.7 % |
| C | 6.5 % | 17.5 | 21/30 | 70.0 % |
| D | 29.1 % | 78.0 | 17/30 | 56.7 % |
| E | 5.5 % | 14.8 | 21/30 | 70.0 % |
| F | 1.3 % | 3.4 | 10/30 | 33.3 % |
| H | 1.3 % | 3.5 | 16/30 | 53.3 % |
| I | 3.9 % | 10.4 | 6/30 | 20.0 % |
| J | 1.4 % | 3.7 | 9/30 | 30.0 % |
| K (not identified) | 0.1 % | 0.2 | 1/20 | 3.3 % |
| L (not identified) | 0.1 % | 0.4 | 3/30 | 10.0 % |
| M | 0.3 % | 0.7 | 6/30 | 20.0 % |
| N | 0.7 % | 1.9 | 4/30 | 13.1 % |
| O | 0.2 % | 0.6 | 4/30 | 13.1 % |
| P (not identified) | 0.7 % | 1.8 | 1/30 | 3.3 % |
| Q | 0.5 % | 1.4 | 5/30 | 16.7 % |
| R (not identified) | 0.5 % | 1.3 | 4/30 | 13.1 % |
| Unidentified | 42.2 % | 113.3 | | |

far upstream, they were always schooled in groups from 10 to 100, rather than being scattered over a large feeding area.

From the preceding evidence, it is recommended that food studies from this stream be deleted from this study, except for comparison.

Sampling of the Richardson Clearwater

This stream was sampled only three times during the work season. Therefore, a continuing record of stream flow and water temperature could not be maintained. All water samples indicated that water temperature ranges from 42° F. to 48° F. Stream flow at the confluence with the Tanana River was estimated to be 120 cfs to 130 cfs.

Although smaller, this stream closely resembles the Delta Clearwater, both in appearance and in the type of aquatic biota it supports. Random bottom samples were comparable in both quantity and variety of organisms to samples taken from the Delta Clearwater.

A total of 13 stomach samples was collected from this stream and analyzed volumetrically. The results are tabulated in TABLE 3. A close correlation, both in total quantity and frequency of occurrence, appears to exist between the samples from the Richardson Clearwater and the Delta Clearwater, although the sample sizes are too limited to afford any firm conclusions.

In this stream grayling were customarily found schooled, and adequate quantities of food are available throughout the stream. Therefore, it is also recommended that all food studies be terminated on this stream, except for comparison.

Sampling of the Goodpaster River

The Goodpaster River was sampled several times during the work season and 24 stomach samples were collected. The tabulated results of their analysis are found in TABLE 4. Stomachs were collected and bottom samples were taken in the main channel and in both forks. Stream flow is reduced to about 290 cfs at the confluence with the Tanana River during low water conditions. However, eroded banks and scars on the riverbank trees indicate a large variation in flow. Water temperatures were also highly variable, ranging from near the freezing point to above 60° F.

TABLE 3. Organisms Taken From the Stomachs of Grayling Collected From the Richardson Clearwater River (1963)

Richardson Clearwater

Total Samples 13

Total Contents 51.4 ml (Average 3.9 ml/sample)

Total Identified 17.1 ml (33.3 %)

| Group | % of Diet | Total Contents (in Milliliters) | Frequency of Occurrence | |
|---|---|---|---|---|
| B | 5.2 % | 2.7 | 11/13 | 84.6 % |
| C | 6.8 % | 3.5 | 11/13 | 84.6 % |
| D | 10.3 % | 5.3 | 5/13 | 38.5 % |
| E | 0.8 % | 0.4 | 5/13 | 38.5 % |
| F | 0.2 % | 1.0 | 3/13 | 23.1 % |
| H | 0.8 % | 0.4 | 4/13 | 30.8 % |
| I | 4.5 % | 2.4 | 3/13 | 23.1 % |
| J | 0.6 % | 0.3 | 3/13 | 23.1 % |
| L | 0.2 % | 0.1 | 2/13 | 15.4 % |
| M | 0.6 % | 0.3 | 4/13 | 30.8 % |
| O | 0.4 % | 0.2 | 3/13 | 23.1 % |
| Q | 1.0 % | 0.5 | 3/13 | 23.1 % |
| Unidentified | | 34.3 | | |

TABLE 4. Organisms Taken From the Stomachs of Grayling Collected From the Goodpaster River (1963)

Goodpaster River

Total Samples 24

Total Contents 41.8 ml (Average 1.7/sample)

Total Identified 18.5 ml (44.2 %)

| Group | % of Diet | Total Contents (in Milliliters) | Frequency of Occurrence | |
|---|---|---|---|---|
| B | 1.4 % | 0.6 | 3/24 | 12.5 % |
| C | 5.3 % | 2.2 | 5/24 | 20.8 % |
| D | 1.2 % | 0.5 | 1/24 | 4.1 % |
| E | 0.7 % | 0.3 | 2/24 | 8.3 % |
| I | 5.8 % | 2.4 | 2/24 | 8.3 % |
| M | 7.9 % | 3.3 | 13/24 | 54.2 % |
| P | 0.2 % | 0.1 | 1/24 | 4.1 % |
| S | 18.7 % | 7.8 | 7/24 | 29.1 % |
| Spruce Needles | 0.7 % | 0.3 | 2/24 | 8.3 % |
| Unidentified | 55.7 % | 23.3 | | |

The greatest density of food organisms, aquatic vegetation and grayling were found in the North Fork, where a coarse gravel bottom was prevalent. Bottom samples revealed considerable numbers of Group B and Group M (TABLE 1). A significant number of Group S was found in the stomachs collected in the North Fork during the early part of September. This may indicate a partial dependence on nonaquatic insects.

The South Fork contained a relatively small percentage of the grayling in this system. Most grayling in this fork were quite small, few of which were 10 inchs in fork length. The stream bottom is composed almost entirely of fine sand. Repeated bottom sampling did not reveal any fish food items and all observed grayling were feeding at or near the surface.

Large amounts of South Fork sand has been expelled into the main river channel during periods of high runoff. The main river channel undergoes intense scouring and the spaces between the rocks are tightly packed with sand. The bottom of the main channel resembles rough concrete in texture with very little aquatic vegetation present. The productivity of this portion of the stream is quite low, with some Group B and M present.

Behavior of grayling in the Goodpaster differed sharply from the other streams. Except in the North Fork, no schooling was evident, with individuals randomly distributed over all available feeding areas. Most food was observed to be taken at or near the surface. Grayling fed actively on any type of artificial fly except during a brief period just before dark, when a few could be caught on any type of lure.

Food availability may be a critical factor influencing behavior and migration in this stream. It is recommended that a significantly larger program of bottom sampling and stomach analyses be undertaken to evaluate the food relationships in this stream.

## MOVEMENTS AND MIGRATIONS

During the field season of 1963, the tag and recovery crew made 152 tag recoveries. The recoveries were made in the Delta Clearwater River, Goodpaster River, Richardson Clearwater River and Shaw Creek (TABLE 5). The majority of the fish (141 of 152 or 93 per cent) were recovered in the same river in which the fish were tagged (1960 through 1963), illustrating a tendency to return to the same stream year after year.

Eleven fish were recovered in a stream other than the stream in which they were tagged. Eight of the 11 (73 per cent) were recovered in the Delta Clearwater. (Seven of the recovered were tagged in the Goodpaster River.) The other fish came from Shaw Creek (TABLE 6). The table illustrates the tendency in 1963 to migrate into the Delta Clearwater River and Richardson Clearwater River from the Goodpaster. This implies that the Goodpaster River has a strong emigration which supplements the Richardson Clearwater and Delta Clearwater Rivers' grayling population. However, the singular emphasis on the Goodpaster River may be an error. Shaw Creek could also support an emigrating population. In the past years, much effort has been devoted to tagging grayling in the Goodpaster, but not Shaw Creek.

Fishermen recovered 50 fish that were tagged in 1963. In addition, fish that were tagged in preceding years were recovered. However, this data will be evaluated at a later date in a cumulative effort when the fishermen recovery data will be summarized.

The interstream movements that were recorded between tag date and recovery date usually did not occur in the same year. One out of eleven interstream movements was tagged in June 1963 in the Goodpaster and recovered in July 1963 in the Delta Clearwater River.

While some fish do begin in one stream system, drop into the Tanana River and enter another stream system all in the same year, most fish remain in the same stream at least during the ice-free period. The majority of the interstream movements require two or more years. The fish enter one stream and remain through the summer. During the fall, the fish apparently move out of the stream and over-winter presumably in the Tanana, at which time the populations may mix. Apparently intermixing of the stream populations occurs in the over-wintering location.

The mixing of stream populations may explain some of the interstream movements. However, the intermingling does not explain the tendency of the fish to move into the Richardson Clearwater River and Delta Clearwater River from the Goodpaster River. The movements do not appear to be random, but seem to have a direction. Thus, the over-wintering intermingling hypothesis does not solve the problem.

The tag recovery program clearly indicates a strong tendency to return to the same stream year after year. This tendency is most strong in the Richardson Clearwater and Delta Clearwater. The tag recovery results also

TABLE 5. Comparison of the Area in which the Grayling were Tagged to the Area in which the Grayling were Recovered (Tanana River Drainage - 1963)

| | |
|---|---|
| Tagged Delta Clearwater and Recovered Delta Clearwater | 86 |
| Tagged Delta Clearwater and Recovered Goodpaster | 1 |
| Tagged Goodpaster and Recovered Delta Clearwater | 7 |
| Tagged Goodpaster and Recovered Richardson Clearwater | 2 |
| Tagged Goodpaster and Recovered Goodpaster | 20 |
| Tagged Richardson Clearwater and Recovered Richardson Clearwater | 35 |
| Tagged Shaw Creek and Recovered Delta Clearwater | 1 |

TABLE 6. Inter-stream Movement Tendencies (Tanana River Drainage - 1963)

| | |
|---|---|
| **Recovered Delta Clearwater and Tagged Elsewhere:** | |
| Goodpaster | 7 |
| Shaw Creek | 1 |
| **Recovered Richardson Clearwater and Tagged Elsewhere:** | |
| Goodpaster | 2 |
| **Recovered Goodpaster and Tagged Elsewhere:** | |
| Delta Clearwater | 1 |

show that the grayling population of the Goodpaster River contributes significant numbers of fish to the Delta Clearwater and Richardson Clearwater grayling populations.

## GROWTH RATE

The average growth rates of the fish were determined for each stream. The data was taken from fish that were tagged in the years 1958 through 1963 and recovered in 1963. Only recoveries made by the tagging crew were used. The well demonstrated tendencies of fishermen to magnify their fish resulted in eliminating their catch data from the growth rate sample.

The growth data was broken into two blocks of information. The first was taken from 1963 tagged fish recovered in 1963. This block of data utilized the comparatively short time interval from the tagging date to the recovery date. The interval ranged from 5 days to 2 months and 3 weeks. From this information the summer growth was determined. The summer period was considered to be May 15 through August 15. With the summer growth determined, the remaining growth must occur during the following 9 months in the "winter" growth period.

The second block of data consisted of fish that were tagged in the 1958 through 1962 period and were recovered in 1963. Since virtually all the fish were recovered only in the summer period, and these fish were tagged in one year and recovered later years, the time interval involved includes winter growth periods. The time intervals ranged from 8-1/2 months to 5 years and 1/2 month.

The years and weeks were converted into months, with the growth rate then calculated as inches per month. The yearly rate was calculated from the monthly rate (monthly rate times 12).

As can be seen from TABLE 7, the population of grayling from the Delta Clearwater grows at a rate of nearly 1-1/2 inches per year (1.4 inches per year). This compares with 1.2 inches per year for the Richardson Clearwater and 1.0 inches per year for the Goodpaster.

The weekly growth rates in tenths of inches show relationships similar to the annual growth rate. The Delta Clearwater fish grow at a rate of .13 inches per week. The Richardson Clearwater fish sprout .12 inches per week, and the Goodpaster River fish grow .05 inches per week.

TABLE 7. Observed Growth Increments - 1963. (Grayling - Tanana River Drainage)

| | Weekly in./wk | Monthly in./mo. | Yearly in./yr.* |
|---|---|---|---|
| Delta Clearwater | .13 | .12 | 1.4 |
| Richardson Clearwater | .12 | .10 | 1.2 |
| Goodpaster | .05 | .08 | 1.0 |

*Monthly growth increment multiplied by 12.

TABLE 8. Grayling Growth Increments (Tanana River Drainage - 1963)

| | Observed Weekly Growth in./wk | Calculated Summer Growth (3 mo.) | Observed Annual Growth |
|---|---|---|---|
| Delta Clearwater | .13 | 1.6 | 1.4 |
| Richardson Clearwater | .12 | 1.4 | 1.2 |
| Goodpaster | .05 | .6 | 1.0 |

*Observed weekly growth increment multiplied by 12.

TABLE 9. Scale Diameters (Scales taken from Grayling Caught During the 1963 field work on the Tanana River Drainage)

| | Year Class | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0+ | 1+ | 2+ | 3+ | 4+ | 5+ | 6+ | 7+ |
| Delta Clearwater | .47 | .96 | 1.38 | 1.71 | 2.04 | 2.30 | 2.49 | 2.26 |
| Richardson Clearwater | .40 | .79 | 1.15 | 1.43 | 1.81 | 2.22 | 2.57 | |
| Goodpaster | .44 | .85 | 1.18 | 1.46 | 1.65 | 1.82 | 1.82 | 2.13 |

In an attempt to illustrate and separate the growth increment added during the summer and winter periods, the weekly increments were manipulated to estimate growth for the total summer (three months). In both the Delta Clearwater and Richardson Clearwater Rivers, the calculated summer growth (weekly increment x 12) is greater than the observed annual increment. The Goodpaster River summer increment is significantly smaller than the yearly increment. This inconsistency is attributed to the small sample of fish (five) from which the data was extracted (TABLE 7). The conclusion is made that virtually all the growth occurs during the summer period since the total average weekly increment during the summer exceeds the observed annual increment in two of the three rivers, and the third set of data came from an extremely small sample.

It can also be seen from the observed increments that the fish grow most rapidly in the Delta Clearwater. The fish of the Goodpaster River grow slowest with the Richardson population mid-way between these two growth increments. It has been hypothesized that the different growth increments can be attributed to food availability. Field studies in subsequent years should provide answers to this problem.

## SCALES

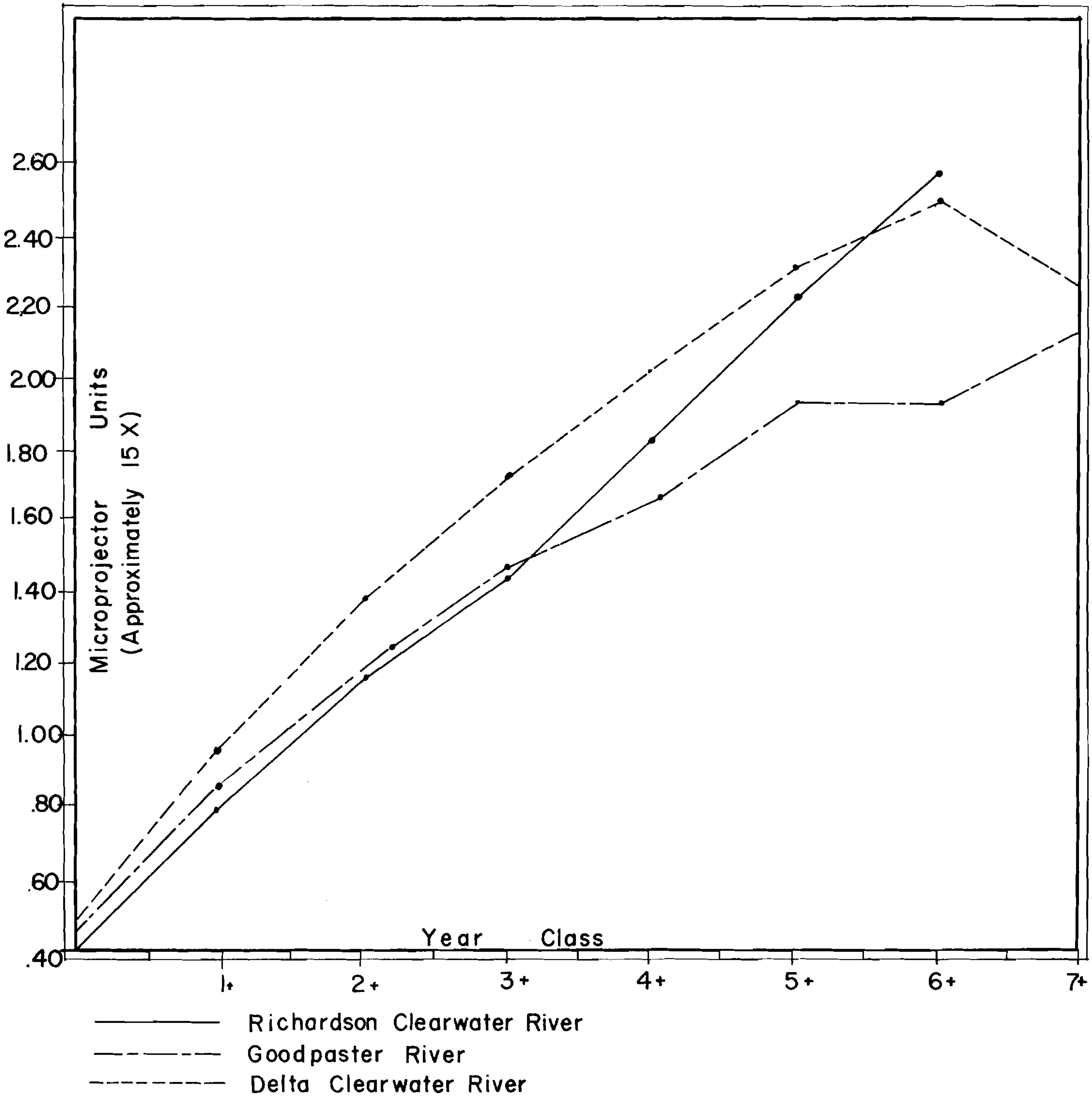
Scales were taken from all fish during the 1963 field season. The scales were retained in coin envelopes until winter when impressions were made. The scale impressions were read using a Bausch and Lomb microprojector. The reading consistent of aging the fish, counting the annuli and measuring the distance from the focus of the scale to the outer edge of the annulus for each year.

FIGURE 1 and TABLE 7 illustrate the relationship of scale growth of the populations of the three streams. As pres-nted in this graph, the scales approximate straight-line growth.

The scale growth from the three streams follows the same general pattern. Some variation exists at 0+. The Delta-Clearwater scales are larger. Each year the size difference increases until 3+ when the Richardson Clearwater sample begins to grow more rapidly. The rapid growth continues until the 5+ or 6+ year when the Delta Clearwater sample is surpassed. The Goodpaster Group exhibits regular growth until 5+ when no growth is shown the following year.

Figure I.

Measurements of Grayling scales taken from Tanana River drainage 1963, illustrating straight line relationship of scales from different rivers.



All three lines fit a regular pattern, different for each stream, until the 5+ year, at which time the growth appears to cease for a year, but continues at a normal rate the following year. The Delta Clearwater sample exhibits a peculiar reduction is size shown in the 7+ sample. Both these irregularities in the curve may well be attributed to the difficulty in reading scales of fish this age.

| Prepared by: | Approved by: |
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| Date: March 15, 1964 | Alex H. McRea, Director<br>Sport Fish Division |